SUBSURFACE TERRESTRIAL MICROFOSSILS FROM COLUMBIA RIVER BASALT SAMPLES: ANALOGS OF FEATURES IN MARTIAN METEORITE ALH84001? Kathie L. Thomas-Keprta[1], Susan J. Wentworth[1], David S. McKay[2], Anne E. Taunton[3], Carlton C. Allen[1], Christopher S. Romanek[4], and Everett K. Gibson[2] [1]Lockheed-Martin, C-23, NASA/JSC, Houston, TX 77058; [2]NASA/JSC, Houston, TX 77058; [3]Department of Chemistry and Biochemistry, University of Arkansas, Fayetteville AR 72701; [4]SREL, Drawer E, University of Georgia, Aiken, SC 29802.

The purported nanofossils in the martian meteorite ALH84001 [1] are considerably smaller than known fossilized bacteria in terrestrial rocks [2]. The small size of the martian features is one of the primary objections to the possibility that the features represent evidence of martian biogenic activity. Nanobacteria, with sizes similar to those of the martian features, have been reported from terrestrial sedimentary rocks [*e.g.*, 3, 4], but the existence of terrestrial nanobacteria is controversial because their identification as bacteria is based on morphology alone. We have undertaken a study of a variety of terrestrial rock samples in order to characterize the range of terrestrial microbial features, and to help determine the nature and origin of the possible nanofossils in ALH84001. Subsurface samples from the Columbia River Basalt (CRB) group are a unique type of possible analog. ALH84001 is more similar in nature and composition to the CRB samples, which are also igneous and ferromagnesian, than to other fossil-bearing terrestrial rock types, which are sedimentary. The CRB formed 6-17 Ma ago and contain very little organic carbon, but populations of anaerobic microorganisms have been detected [5]. Earlier workers [5] performed experiments on CRB samples from core samples extracted from several hundred meters beneath any sediments. For the experiments, microcosms were established in which sterilized basalt chips were exposed to CRB groundwater containing entrained microorganisms, and various nutrients were added to facilitate microbial growth. A variety of metabolites was produced including methane. The energy source used by the CRB microbes was H_2 produced by the interaction of water and the Fe-rich rock; photosynthesis was not involved in any part of the process. The morphology of the organisms that produced the metabolites was not studied by [5]; therefore, we have examined CRB chips used in the microcosms by means of high-resolution field emission gun scanning electron microscopy (FEG-SEM) for *in situ* microbes and transmission electron microscopy (TEM) for microbes extracted from the CRB surface.

Our studies show that surfaces of the CRB samples used for the microcosms of [5] contain micrometer-sized (*i.e.*, normal-sized) bacteria in various states of fossilization, ranging from unfossilized (recently dead) cells, composed primarily of C, P, S, Na, and Cl, to those that have been completely replaced by Fe-rich and Fe-, Mn-rich minerals. Filaments, ranging from 10-30 nm wide and up to several micrometers in length, are also common on the CRB grain surfaces. They occur intertwined in groups or as single filaments, and are composed primarily of ferrihydrite, along with minor amounts of Ca, P, and Si. We suggest that these filaments are mineralized nanobacteria or appendages of bacteria. Terrestrial bacteria commonly have appendages, which are used for locomotion, attachment, or reproduction. Bacterial appendage types include flagellae, fimbrae (pilli, stalks, tubules), and prosthecae (hyphae), all of which are in the same size range as the CRB filaments. The CRB filaments are generally similar in diameter to the purported nanofossils in ALH84001, but the CRB filaments are usually longer than those in the martian meteorite. Additional work, including analysis for DNA in the CRB filaments, is presently under way. If DNA is present, this would be the first report documenting the presence of biological nano-sized filaments from a non-sedimentary rock.

[1] McKay et al. (1996) *Science* **273**, 924; [2] Schopf and Packer (1987) *Science* **237**, 70; [3] Folk (1993) *J. Sed. Pet.* **63**, 990; [4] Buczynski and Chafetz (1991) *J. Sed. Pet.* **61**, 226; [5] Stevens and McKinley (1995) *Science* **270**, 450.